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An Assessment of Progress in Cancer Control

Rebecca L. Siegel, MPH[1]; Ahmedin Jemal, DVM, PhD [2]; Richard C. Wender, MD[3];
Ted Gansler, MD, MPH, MBA [4]; Jiemin Ma, PhD[5]; Otis W. Brawley, MD[6]

[1]Scientific Director, Surveillance Research, American Cancer Society, Atlanta, GA; [2]Vice President, Surveillance and Health Services Research, American Cancer Society, Atlanta, GA; [3]Chief Cancer Control Officer, American Cancer Society, Atlanta, GA; [4]Strategic Director, Pathology Research, American Cancer Society, Atlanta, GA; [5]Senior Principal Scientist, Surveillance Research, American Cancer Society, Atlanta, GA; [6]Chief Medical and Scientific Officer and Executive Vice President-Research, American Cancer Society, Atlanta, GA.

Corresponding author: Rebecca L. Siegel, MPH, Surveillance and Health Services Research, American Cancer Society, 250 Williams St, NW, Atlanta, GA 30303-1002; rebecca.siegel@cancer.org

Abstract: This article summarizes cancer mortality trends and disparities based on data from the National Center for Health Statistics. It is the first in a series of articles that will describe the American Cancer Society's vision for how cancer prevention, early detection, and treatment can be transformed to lower the cancer burden in the United States, and sets the stage for a national cancer control plan, or blueprint, for the American Cancer Society goals for reducing cancer mortality by the year 2035. Although steady progress in reducing cancer mortality has been made over the past few decades, it is clear that much more could, and should, be done to save lives through the comprehensive application of currently available evidence-based public health and clinical interventions to all segments of the population. CA Cancer J Clin 2018;68:329-339. © 2018 American Cancer Society.

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Cancer Control and Cancer Outcomes

Cancer control is a discipline that began in the early 1900s with an emphasis on early detection (through prompt recognition of signs and symptoms) and surgical treatment of disease. It became a formal scientific discipline in the 1950s with the dissemination of the Papanicolaou test and the discovery that tobacco causes lung cancer. Today, the National Cancer Institute (NCI) defines cancer control as activities to reduce the cancer burden through dissemination and delivery of evidence-based interventions. These interventions can focus on prevention, early detection, or treatment.[1]

There are 3 measurements of population data that are commonly used to assess progress in cancer control—incidence rates, survival rates, and death rates. All 3 metrics are useful, but, as a single measure of progress, death rates are the most informative. Population-level incidence rates are chiefly affected by levels of exposure to risk factors and availability and use of early-detection tests. Of note, effective screening can lead to increased cancer incidence rates through detection of prevalent cases or reductions in incidence when the cancer has a treatable precursor lesion. The introduction and dissemination of new diagnostic techniques such as imaging also affects incidence rates through detection of indolent cancers. Differences in screening prevalence and detection practice over time and among population segments thus can limit the interpretation of incidence rates. Increases in survival rates, and especially 5-year survival rates, can indicate progress, but this metric is similarly susceptible to detection-related biases and is commonly misunderstood and misused. Because the cancer mortality or death rate is less affected by detection practices and reflects the overall outcome of prevention, early detection, and treatment, a downward trend in this measure is the best indication of cancer control progress.[2,3]

Assessment of outcomes is impossible without high-quality, population-based data. These data are gathered by registrars working in treatment facilities in communities throughout the United States and in central cancer registries that are funded by the US Centers for Disease Control and Prevention and/or the NCI.[4] The Surveillance, Epidemiology, and End Results (SEER) program of the NCI
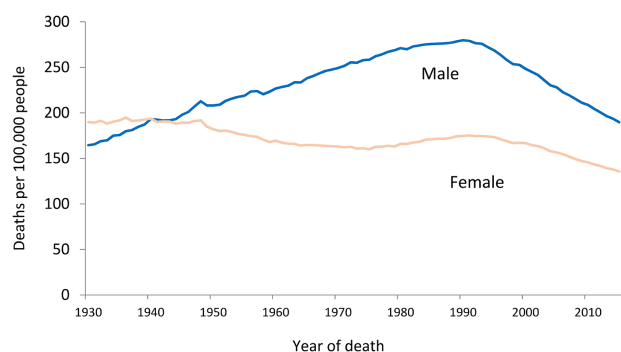
FIGURE 1. Trends in Age-Standardized Cancer Death Rates Among Males and Females in the United States, 1930 to 2015. Rates are age adjusted to the 2000 US standard population and are presented per 100,000 person-years. Data source: National Center for Health Statistics.

reports long-term, population-based incidence data covering up to 28% of the US population. The North American Association of Central Cancer Registries (NAACCR) compiles and reports incidence data from cancer registries that participate in the SEER program or the Centers for Disease Control and Prevention's National Program of Cancer Registries. The NAACCR data cover up to 95% of the US population for the contemporary time period.[5]

Mortality Trends

Cancer mortality rates (age-adjusted to the 2000 US standard population) for men and women from 1930 to 2015 are shown in Figure 1. The rate for men rose through most of the 20th century because of increases in tobacco-related cancers, especially lung cancer. The cancer death rate for women decreased during the mid-20th century because of declines in cervical, liver, colorectal, and gastric cancer.

The rise in the death rate for women beginning in the mid-1970s was because of increases in cigarette smoking during the period from 1940 to 1965. For both sexes combined, the death rate peaked at 215 deaths per 100,000 in 1991 and steadily declined to 159 per 100,000 in 2015. This represents a 26% decline in cancer mortality in 24 years, translating into almost 2.4 million cancer deaths averted.[6]

The continuous decrease in cancer mortality since 1991 is primarily because of the rapid declines in death rates for lung, colorectal, breast, and prostate cancer (Table 1). These 4 cancers collectively account for almost half of all cancer deaths, so their trends have a large influence on overall cancer mortality patterns. The death rate for these 4 cancers combined declined 36% from 1991 to 2015, compared with a decline of 14% for all other cancers combined during the same period.

The reasons for the decline in mortality rate include:

- Cancer prevention, primarily through reductions in smoking for lung and other smoking-related cancers, but also through screening via the removal of precancerous lesions for colorectal and cervical cancers.
- Improvements in screening and early detection, because earlier detection improves the efficacy of treatment for most cancers, even in the absence of treatment advances. This explains some of the declines in cancers of the breast, colon, rectum, cervix, and, to a lesser degree, prostate.
- Improvements in cancer treatment, including reductions in surgical mortality, improvements in surgical and radiation management, and advances in systemic treatment, such as the development of targeted therapies for hematopoietic and lymphoid cancers.

TABLE 1. Decline in Cancer Mortality Rate From the Peak Year Through 2015 for the Four Major Cancers Types.

CANCER SITE	PEAK YEAR FOR MORTALITY	MORTALITY RATE IN PEAK YEAR	MORTALITY RATE IN 2015	PERCENT DECLINE
All cancers	1991	215.1	158.7	26%
Male	1990	279.8	189.9	32%
Female	1991	175.3	135.8	23%
Lung	1993	59.1	40.6	31%
Male	1990	90.6	49.8	45%
Female	2002	41.6	33.6	19%
Colorectal	1969*	29.4	14.0	≥52%
Male	1980	33.7	16.6	51%
Female	1969*	26.7	11.8	≥56%
Breast (female)	1989	33.2	20.3	39%
Prostate	1993	39.3	18.9	52%

Mortality rates are per 100,000 people and age adjusted to the 2000 US standard population.
Data source: National Center for Health Statistics.
*Comparable data prior to 1969 unavailable.

Mortality trends for individual cancers demonstrate successes, as well as opportunities and challenges, in cancer control. The following are a few examples.

- Lung cancer is still the leading cause of cancer death in American men and women. The decline in the lung cancer death rate is directly related to the decline in lung cancer incidence, which, in turn, was because of declines in smoking prevalence.[7,8] American adult male smoking prevalence has dropped from a peak of 55% in 1955 to 17% in 2015. Similarly, smoking prevalence in women declined from a peak of 35% in 1965 to 14% in 2015. However, with these declines, the profile of the American smoker has changed substantially, with disproportionately higher prevalence in vulnerable populations, including less educated and low-income individuals.[9,10] Smoking and the mortality associated with it also varies significantly by state.[11] Smoking has been linked to at least 12 different cancers. Although the decline in smoking is the biggest driver in the 26% decline in cancer death rates, tobacco use is still the leading cause of cancer in the United States, accounting for an estimated 19% of all cancers diagnosed and 29% of all cancer deaths in 2014.[12]

- Gastric cancer was the leading cause of cancer death in men and the second leading cause in women in 1930, yet today it is not among the top 10. The age-adjusted death rate per 100,000 has declined from 46 in 1930 to 4 in 2015 among men and from 35 in 1930 to 2 in 2015 among women.[6,13] This dramatic decline is largely because of public health measures. Improvements in hygiene reduced the prevalence of *Helicobacter pylori (H. pylori)* infection and improvements in food preservation, especially refrigeration, reduced exposure to salt and nitrates. Infection with *H. pylori* and the consumption of salt- and nitrate-preserved food increase risk of gastric cancer.

- Uterine corpus and cervix cancer was the leading cause of cancer death among women in 1930. Data from that period did not classify mortality separately for cancers of the uterine corpus and cervix, and the combined death rate was 36 (per 100,000). The cervical cancer death rate had dropped to 5.6 in 1975 and to 2.3 in 2015 (the respective uterine corpus death rates were 5.3 and 4.7).[6,14] The progress against cervical cancer is attributed to the development and widespread implementation of Papanicolaou test screening, as well as improvements in treatment of cervical cancer precursors and invasive disease. The dissemination of the combination of human papillomavirus vaccination and cervical screening has the potential to virtually eliminate cervical cancer as a major cause of morbidity and mortality worldwide, although uptake of the vaccine remains low in the United States at only 47.5% in 2016.[15]

- Death rates from liver and intrahepatic bile duct cancer rose from 2.8 (per 100,000) in 1975 to 6.5 in 2015.[6] Although alcohol is an important cause of liver cancer, this rise is largely attributed to the increased incidence of hepatitis C infection during the 1960s to 1980s, as well as escalating obesity.[16,17] The increase in intrahepatic bile duct cancer rates may also be contributed to by Vietnam veterans' exposure to liver parasites.[18,19]

- The age-adjusted mortality rates of non-Hodgkin lymphoma rose from 5.6 (per 100,000) in 1975 to 8.9 in 1997, in part due to higher incidence resulting from the human immunodeficiency virus epidemic.[20] The rate declined to 5.7 in 2015, because of reduced incidence, partly attributed to the introduction of highly active antiretroviral therapy (HAART), and improvements in non-Hodgkin lymphoma treatment.[6,21]

- Pancreatic cancer is the fourth leading cause of cancer death in both men and women and the third leading cause of cancer death when men and women are combined, with an estimated 44,330 deaths in 2018.[6] Over the past 40 years, the age-adjusted pancreatic cancer death rate has been relatively stable at 10.5 to 11.0 deaths per 100,000. In 2015, it was 10.7.

Childhood and Adolescent Cancer

Cancer is the second most common cause of death among children aged 1 to 14 years in the United States, surpassed only by accidents. Approximately 1 in 279 children will be diagnosed with cancer before age 20 years, and about 175,000 young adults between the ages of 20 and 39 years is a childhood cancer survivor.[22,23] In 2018, an estimated 15,700 children and adolescents (aged birth to 19 years) will be diagnosed with cancer, and 1700 will die from the disease. Cancer incidence rates increased in children and adolescents by 0.6% per year from 1975 through 2014.[6] In contrast, death rates have declined continuously, from 6.5 (per 100,000 population) in 1970 to 2.3 in 2015, an overall reduction of 65% (67% in children and 61% in adolescents). The most common tumors in pediatric patients are very different from those in adults (Table 2).

The substantial progress for all of the major childhood cancers is because of improvements in treatment and has been facilitated by high levels of participation in clinical trials. Unfortunately, a substantial proportion of survivors of childhood cancer grow into adulthood with comorbidities associated with the disease or its treatment.[24] It is estimated that most pediatric cancer survivors have at least 5 comorbid conditions and that long-term survivors of childhood or adolescent cancers are 8 times more likely to have a serious chronic health condition than siblings who had not been

TABLE 2. Cancers in Childhood and Adolescence

CANCER TYPE	DISTRIBUTION, %
Children aged birth to 14 y	
Leukemia	29
Cancers of the brain and nervous system type	26
Soft tissue sarcomas	6
Neuroblastoma	6
Non-Hodgkin lymphomas, including Burkitt	5
Renal (Wilms) tumors	5
Hodgkin lymphomas	3
Adolescents aged 15 to 19 y	
Cancers of the brain and nervous system	21
Leukemia	13
Hodgkin lymphoma	12
Gonadal germ cell tumors	11
Thyroid carcinoma	11
Melanoma	4

diagnosed with cancer.[25] Common side effects from therapy include: growth retardation, cognitive impairment, cardiopulmonary difficulties, impairment of sexual function, infertility, posttraumatic stress disorder, and secondary cancers. Current pediatric research is aimed at improving the treatments, making them more efficacious, and decreasing the temporary and permanent side effects of therapy. Although the significant success in pediatric cancer has spurred the discipline of "cancer survivorship," there is still much work to do.

Disparities in Cancer Outcomes

There are differences in cancer mortality among populations categorized by race/ethnicity, economic and educational level, or region of residence. Many disparities are due largely to a failure to get adequate medical care to Americans who need it.[26,27] This includes preventive care, such as education and other interventions to promote adoption of a healthy lifestyle (ie, eating a healthy diet, exercising, and not smoking), as well as vaccinations and cancer screening.

Racial and Ethnic Disparities

Racial categories for federal data are loosely linked to place of geographic origin and are defined by the US Office of Management and Budget (OMB) for the US Bureau of the Census. These groupings have changed over time, and the OMB notes that they should not be considered as biologic categorizations. Unfortunately, the National Institutes of Health Revitalization Act of 1993 requires researchers funded by the National Institutes of Health to consider race

as a biologic classification.[27] While the populations within these 5 broadly-defined categories are extremely heterogeneous, they do have some characteristics common within them that influence cancer risk. For example, some breast cancer risk factors are influenced by culture, such as age at menarche (which is influenced by diet in childhood) and birthing patterns. In addition, some racial and ethnic minorities, such as black and American Indian and Alaskan Native populations, are much more likely than whites to live in poverty, which was described by former NCI director Samuel Broder as a "carcinogen."[28]

Although black-white cancer data are available from the early 1970s onward, data for the 5 expanded OMB-defined racial/ethnic categories are only available since 1990. The mortality data for all cancers combined from 1990 to 2015 in Figure 2 show persistent differences by race/ethnicity in the rate, as well as in the speed of the decline. For example, over the past 10 data years (2006-2015), the annual percent change in mortality was about 2% in non-Hispanic blacks versus 1% in the 4 other groups.

Many health disparities are caused by inequalities in access to preventive and therapeutic health care. The introduction of a new, effective health intervention often leads to widening disparities between those populations that have access and those who do not. Breast and colon cancer are 2 diseases for which our abilities to screen and treat dramatically improved beginning about 1980.[3,29] The mortality trends by OMB-defined race/ethnicity for female breast cancer, colorectal cancer for men and women, and prostate
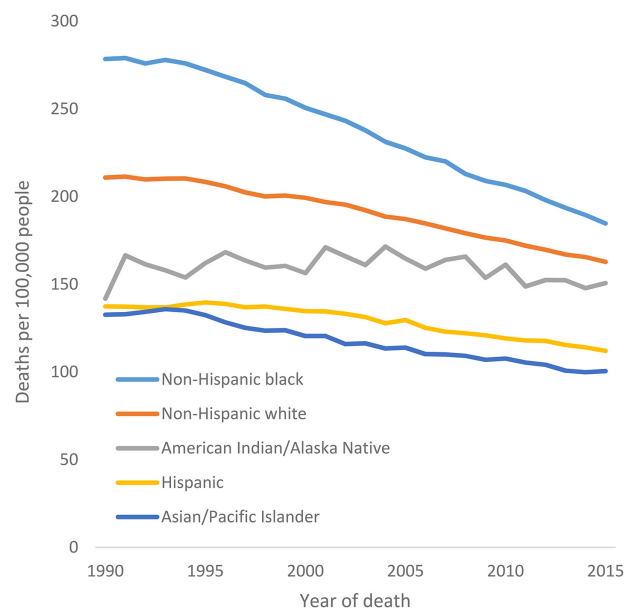

FIGURE 2. Cancer Mortality by Race/Ethnicity From 1990 to 2015.
Rates are per 100,000 and age adjusted to the 2000 US standard population. Rates for American Indians/Alaska Natives (AI/AN) are based on the Contract Health Service Delivery Area (CHSDA) counties. Rates for Non-Hispanic white, Non-Hispanic black, and Hispanic exclude deaths from Louisiana, New Hampshire, and Oklahoma. Data source: National Center for Health Statistics.
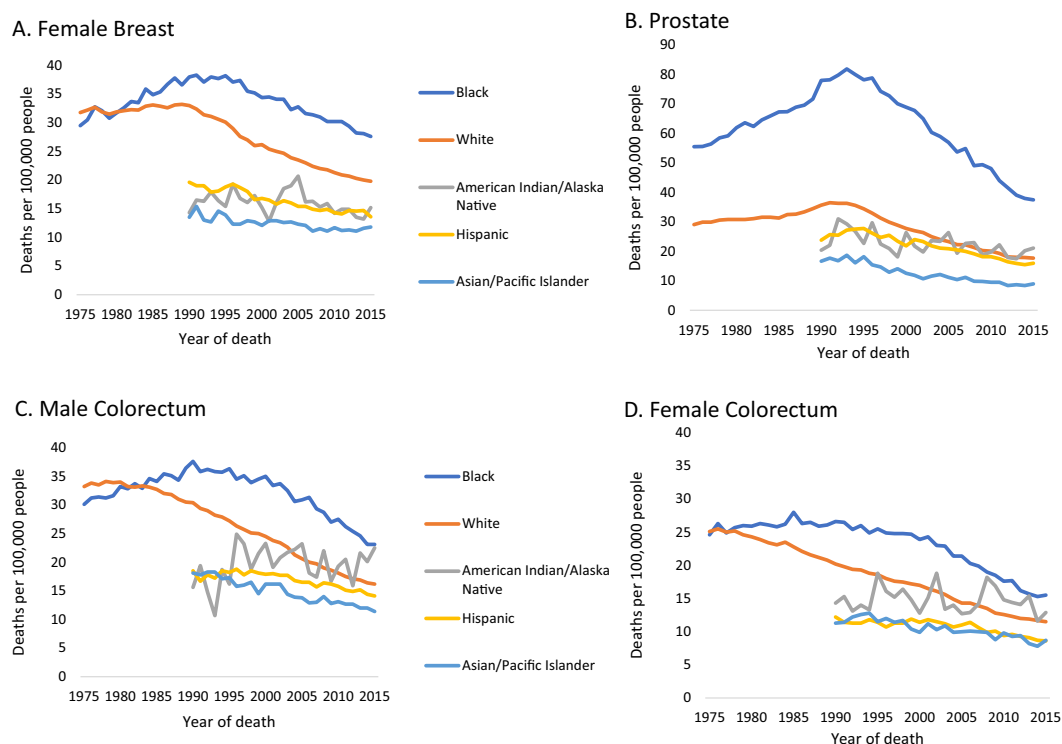
A. Female Breast

B. Prostate

C. Male Colorectum

D. Female Colorectum

FIGURE 3. Cancer Mortality by Race/Ethnicity From 1975 to 2015. Death rates are illustrated for (A) breast cancer (female), (B) prostate cancer, (C) colorectal cancer (male), and (D) colorectal cancer (female).
Rates are per 100,000 and age-adjusted to the 2000 US standard population. Rates for American Indians/Alaska Natives (AI/AN) are based on the Contract Health Service Delivery Area (CHSDA) counties. Rates for Hispanics exclude Louisiana, New Hampshire, and Oklahoma. Rates for whites, blacks, Asians/Pacific Islanders (API), and AI/AN are not exclusive of Hispanic origin. Data source: National Center for Health Statistics.

cancer are shown in Figure 3. Notably, blacks and whites had very similar colorectal and breast cancer death rates in the 1970s; disparities in mortality began and rapidly accelerated in the 1980s with the wide availability of effective screening and treatment. The growing racial disparity in breast cancer mortality during this time is particularly striking given the substantially higher incidence rates in whites than in blacks, which have only recently begun to converge.

There are numerous studies demonstrating racial disparities in breast cancer early-detection and treatment,[26,30-32] including black-white differences in quality of screening, quality of surgery, adequate dosing of chemotherapy, and completion of prescribed radiation therapy. In one survey done in the late 1990s, 45% of black women with breast cancer received less than optimal care compared with 42% of Hispanic women and 32% of white women.[33] Although a high proportion of whites with breast cancer do not receive good care, a black or Hispanic woman is even less likely to receive optimal care. Studies also show that heavier women, less educated women, and poor women are less likely than their counterparts to get optimal breast cancer treatment.[34] There is no evidence that these patterns have dramatically changed since 2000.[35,36] Although the proportion of blacks who are uninsured was halved as a result of the Patient Protection and Affordable Care Act, coverage

gains among patients with newly diagnosed cancer were recently shown to be lowest among blacks compared with Hispanics and whites.[37,38]

In breast cancer, there are some racial differences in pathologic subtypes that influence disparate outcomes. Approximately 22% of black patients with breast cancer have triple-negative disease versus about 12% of white patients.[39] Some of this difference may be because of familial inheritance, but there are data to suggest that environmental factors associated with poverty may also have an influence.[40,41] However, few appreciate that the largest portion of the black-white breast cancer mortality disparity is because of treatment inequalities for estrogen receptor-positive disease, the subtype with the most available treatment options.

Black individuals are less likely than whites to be current for colorectal cancer screening, and there is evidence that the quality of screening colonoscopy varies by race.[7,42] A recent study found that blacks were 30% more likely than whites to be diagnosed with an interval cancer (ie, after a negative colonoscopy but before the next recommended screen) and more often received colonoscopies from physicians who had lower polyp detection rates (46.2% vs 52.8%).[43] This suggests that blacks are more likely to have a colonoscopy performed by less-skilled physicians, most likely because of differences in socioeconomic status (SES) rather than race.
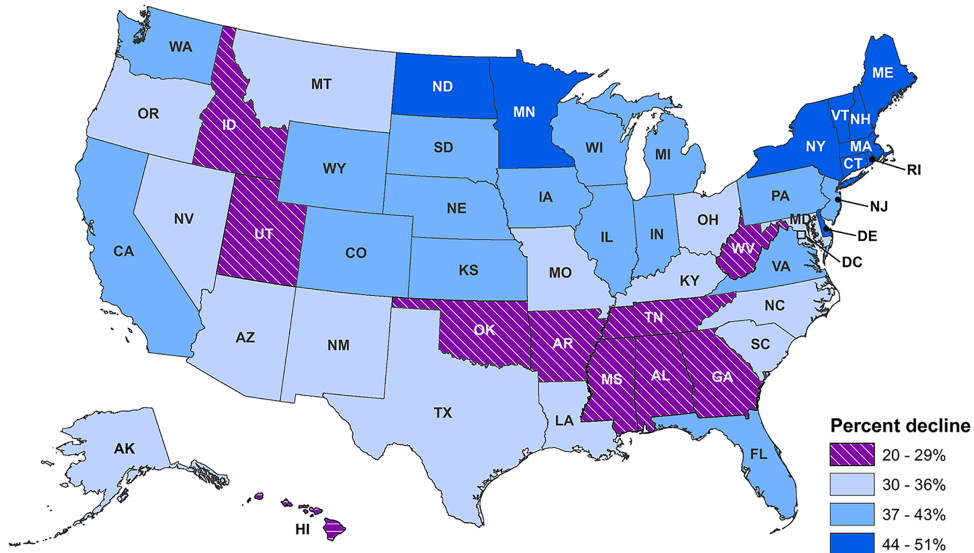
FIGURE 4. Decline in Breast Cancer Mortality Rate From 1988–90 to 2013–15 by State.
Data source: National Center for Health Statistics.

There is also evidence that colorectal cancer pathology specimens are processed differently by race. The observation that blacks with stage II colon cancer (lymph node-negative) are more likely to relapse compared with whites with low stage III disease (1-3 positive lymph nodes) has led many to assume that colon cancer is more aggressive in blacks. The observation, however, is due, at least in part, to blacks being more likely to be understaged.[44] After resection, blacks are less likely than whites to have an adequate number of lymph nodes removed by the surgeon for pathologic evaluation. This, like many black-white disparities, is heavily influenced by SES instead of race. Blacks are more likely to be cared for in busier hospitals where pathologists have heavier workloads and less time to process each surgical specimen.[45,46]

The black-white disparity in prostate cancer mortality partly reflects higher incidence in blacks, which is largely unexplained. Although black men treated in an equal-access system have prostate cancer survival rates very similar to those of white men,[47,48] equal treatment does not occur in the United States. Patterns-of-care studies show differences in prostate cancer treatment by race, some of which may derive from patient choice.[49] Blacks are also more likely to have elements of optimal care missing from disease management, including delays in treatment.[50,51]

Racial and ethnic disparities in survival for childhood and adolescent cancers have also been noted, with lower 5-year survival among black and Hispanic patients compared with white patients.[52] Factors associated with these disparities include SES, parental education and understanding of the disease, health insurance status, timely diagnosis, enrollment in cooperative group clinical trials, quality of treatment and supportive care, and variations in adherence to therapy.[52,53] However, equal
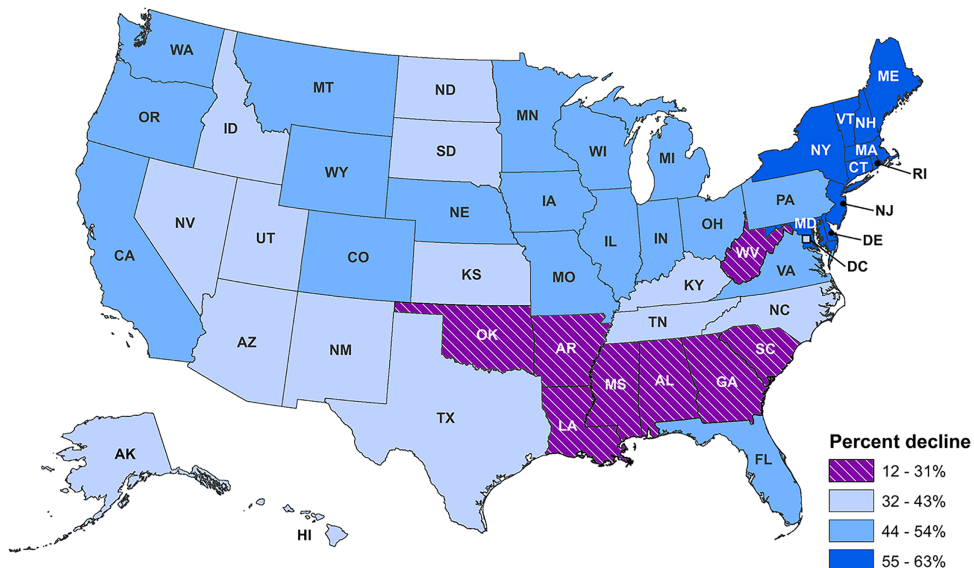

FIGURE 5. Decline in Colorectal Cancer Mortality Rate From 1980–82 to 2013–15 by State.
Data source: National Center for Health Statistics.

(A)

Prevalence (%)

- 8.8 - 11.0
- 11.1 - 15.8
- 15.9 - 18.5
- 18.6 - 21.1
- 21.2 - 24.8

(B)

Rate per 100,000

- 19.5 - 32.2
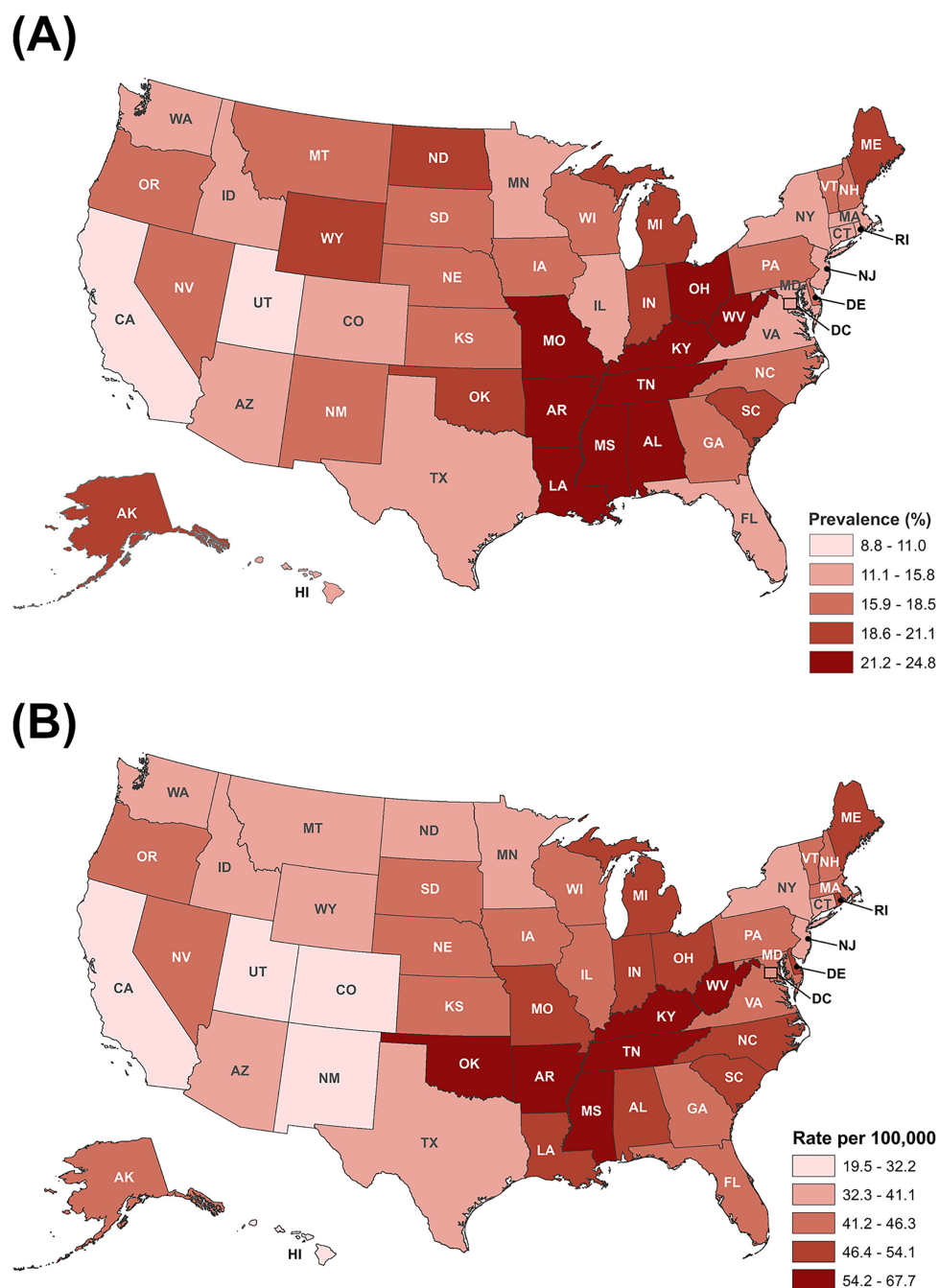- 32.3 - 41.1
- 41.2 - 46.3
- 46.4 - 54.1
- 54.2 - 67.7

FIGURE 6. Adult Smoking Prevalence in 2016 (A) and Lung Cancer Mortality Rates During 2011-2015 (B).
Data source: Smoking: Behavioral Risk Factor Surveillance System (BRFSS), Centers for Disease Control and Prevention Mortality: National Center for Health Statistics.

treatment yields equal outcomes for pediatric cancer as well, so race need not be a factor.[54]

Geographic Disparities

Although much emphasis has been put on racial disparities, there are clear cancer disparities by region of residence irrespective of race. For example, the age-adjusted breast cancer death rate declined by 39% between the periods 1988 to 1990 and 2013 to 2015 overall, but by 20% to 29% in 10 states (Fig. 4).[55] Factors that contribute to geographic

disparities include variations in risk factors and in access to screening and high-quality treatment, all of which are influenced by socioeconomic factors, legislative policies, and proximity to medical services.[35]

The United States has had a 49% decline in colorectal cancer death rates between the periods 1980 to 1982 and 2013 to 2015. However, the decline was 12% to 31% in 8 states, 6 of which also had the smallest reductions in breast cancer mortality (Oklahoma, Arkansas, Mississippi, Alabama, Georgia, and West Virginia) (Fig. 5).[35,55] Of note, state-level

TABLE 3. Age-Standardized Death Rate (Per 100,000) by Educational Attainment, All Races Combined, Ages 25 to 74 Years, 2014[a]

CANCER SITE	≤12 YEARS		13 TO 15 YEARS		≥16 YEARS		RR (95% CI): ≤12 VERSUS ≥ 16 YEARS
	DEATHS	RATE (95% CI)	DEATHS	RATE (95% CI)	DEATHS	RATE (95% CI)	
Lung and bronchus	62,610	61.7 (60.9-62.5)	18,786	28.0 (27.4-28.5)	10,967	16.4 (16.0-16.8)	3.76 (3.65-3.86)
Colon and rectum	15,966	16.6 (16.3-16.9)	6544	10.0 (9.7-10.2)	5578	8.5 (8.2-8.7)	1.95 (1.89-2.02)
Pancreas	12,152	12.1 (11.9-12.4)	5536	8.2 (8.0-8.5)	5390	8.0 (7.7-8.2)	1.52 (1.46-1.58)
Breast (female)	12,497	26.1 (25.5-26.6)	6695	19.1 (18.5-19.6)	6848	21.2 (20.6-21.8)	1.23 (1.19-1.27)
Liver and intrahepatic bile duct	10,885	10.8 (10.5-11.0)	3591	5.1 (4.9-5.3)	2451	3.6 (3.4-3.8)	2.99 (2.85-3.14)
Prostate	5051	10.9 (10.5-11.3)	2144	7.1 (6.7-7.5)	2284	6.5 (6.2-6.8)	1.68 (1.58-1.78)
Leukemia	5499	5.9 (5.7-6.0)	2524	4.0 (3.8-4.1)	2640	4.1 (3.9-4.2)	1.44 (1.37-1.52)
Non-Hodgkin lymphoma	5021	5.2 (5.0-5.3)	2183	3.4 (3.2-3.5)	2194	3.4 (3.2-3.5)	1.54 (1.45-1.62)
Urinary bladder	3534	3.5 (3.4-3.6)	1259	1.9 (1.8-2.0)	1064	1.6 (1.5-1.7)	2.17 (2.02-2.34)
Brain and other nervous system	4967	5.4 (5.2-5.5)	2735	4.2 (4.0-4.4)	3548	5.4 (5.2-5.6)	1.00 (0.96-1.05)
Esophagus	5889	5.9 (5.8-6.1)	2203	3.2 (3.1-3.4)	1773	2.6 (2.5-2.7)	2.27 (2.15-2.40)
Ovary	4158	8.2 (8.0-8.5)	2199	6.1 (5.8-6.4)	2330	7.1 (6.8-7.4)	1.16 (1.09-1.22)
Kidney and renal pelvis	4543	4.6 (4.5-4.7)	1976	2.9 (2.8-3.1)	1706	2.5 (2.4-2.7)	1.82 (1.71-1.93)
Myeloma	2965	2.9 (2.8-3.0)	1343	2.0 (1.9-2.1)	1512	2.3 (2.1-2.4)	1.29 (1.21-1.38)
Stomach	3914	4.2 (4.0-4.3)	1327	2.0 (1.9-2.2)	1228	1.9 (1.8-2.0)	2.22 (2.07-2.37)
Corpus and uterus, NOS	3213	6.1 (5.8-6.3)	1570	4.3 (4.0-4.5)	1521	4.6 (4.3-4.8)	1.33 (1.24-1.42)
Melanoma of the skin	2575	2.8 (2.7-2.9)	1426	2.2 (2.1-2.3)	1597	2.4 (2.3-2.5)	1.17 (1.10-1.25)
Oral cavity and pharynx	3987	4.1 (4.0-4.2)	1356	2.0 (1.9-2.1)	980	1.4 (1.4-1.5)	2.82 (2.62-3.03)
Cervix uteri	2141	5.5 (5.2-5.7)	788	2.4 (2.2-2.6)	444	1.4 (1.3-1.5)	3.95 (3.55-4.39)
Larynx	1911	1.9 (1.8-2.0)	431	0.6 (0.6-0.7)	209	0.3 (0.3-0.4)	6.11 (5.27-7.07)

Abbreviations: 95% CI, 95% confidence interval; NOS, not otherwise specified; RR, relative risk. [a]Rates are age standardized to the 2000 US standard population. Population data are from the American Community Survey (ACS) Public Use Microdata Sample (PUMS) files, 2014 (Washington, DC: US Bureau of the Census).

reductions in colorectal cancer death rates are correlated with the uptake of screening ($r = -0.59$; $P < .0001$).[56]

It is not a surprise that the states with the least progress tend to be those with the highest prevalence of citizens who are socioeconomically deprived and/or black. Notably, although there are several states for which the difference between blacks and whites in the overall cancer mortality rate is not statistically significant,[6] the absence of racial disparity is not always a sign of progress. Kentucky is one of these states, but also has the highest cancer mortality rate in the nation.[6]

There are substantial geographic cancer disparities even among white Americans and by neighborhood within cities that largely parallel differences in SES. The socioeconomically deprived suffer from inequalities across the cancer continuum, from the prevalence of risk factors, such as higher levels of smoking and obesity and lower levels of physical activity,[57] to access to high-quality screening and treatment.[58]

As noted previously, smoking is the leading cause of cancer incidence and mortality, so it is not surprising that geographical differences in tobacco use are strongly associated with these outcomes. Prevalence of current cigarette smoking in 2016 remained as high as 25% in West Virginia and Kentucky, and as low as 11% in California and 9% in Utah (Fig. 6A).[59] Hence, the largest geographic disparity is for lung cancer, with mortality rates ranging from 67.7 per 100,000 in Kentucky to 19.5 per 100,000 in Utah (Fig. 6B). Tobacco use usually begins during adolescence, and one of the most successful ways to discourage teen smoking is to increase cost. States with higher cigarette excise taxes have lower youth smoking rates.[60]

Disparities by Educational Attainment

Educational attainment is a measure of SES. Irrespective of race or area of residence, lower educational attainment is associated with a higher risk of cancer death for all cancers

TABLE 4. Avertable Deaths by Eliminating Educational Disparities, Ages 25 to 74 Years, All Races Combined, 2014

CANCER SITE	NO. OF DEATHS OBSERVED	NO. OF DEATHS EXPECTED[a]	NO. OF DEATHS AVERTABLE	% OF DEATHS AVERTABLE
Lung and bronchus	92,363	38,273	54,090	59
Colon and rectum	28,089	19,137	8952	32
Pancreas	23,077	18,761	4316	19
Breast (female)	26,040	24,483	1557	6
Liver and intrahepatic bile duct	16,927	8494	8433	50
Prostate	9479	7184	2295	24
Leukemia	10,664	9124	1540	14
Non-Hodgkin lymphoma	9399	7603	1796	19
Urinary bladder	5858	3725	2133	36
Brain and other nervous system	11,250	12,113	−863	−8
Esophagus	9865	6170	3695	37
Ovary	8687	8609	78	1
Kidney and renal pelvis	8225	5913	2312	28
Myeloma	5820	5275	545	9
Stomach	6469	4221	2248	35
Corpus and uterus, NOS	6304	5701	603	10
Melanoma of the skin	5598	5488	110	2
Oral cavity and pharynx	6323	3391	2932	46
Cervix uteri	3373	1513	1860	55
Larynx	2552	729	1823	71

Abbreviation: NOS, not otherwise specified. [a]The death rate for the most educated group (bachelor degree or above) was applied to the entire population.

listed in Table 3 except brain and other nervous system tumors. The cancers with the largest relative risks are those for which the disparity is most preventable. These disparities largely reflect inequalities in the prevalence of cancer risk factors, such as smoking, obesity, physical inactivity, an unhealthy diet, and access to high-quality screening and treatment.[61]

In a calculation done for this report, American Cancer Society epidemiologists conservatively estimated that almost one-fourth (22%) of all cancer deaths would not occur if all Americans had the cancer death rates of college-educated Americans. This calculation speaks volumes. More than 134,000 of the 610,000 cancer deaths expected in 2018 would not occur if all Americans had the same levels of exposure to risk factors and received the same quality of care as college graduates. An even larger proportion, 34%, of cancer deaths could be averted among the subset of Americans aged 25-74 years. Table 4 shown the proportion and number of deaths that could be potentially averted in this age group with the elimination of educational disparities for selected cancer types.

The Patient Protection and Affordable Care Act and Cancer Disparities

There are indicators that the Patient Protection and Affordable Care Act (ACA) has increased access to all phases of cancer care: preventive as well as diagnostic and treatment services.[62-66] From 2011 to 2014, the proportion of patients with newly diagnosed cancer aged 18 to 65 years who were uninsured declined from 9.6% to 3.6% in states that expanded Medicaid versus 14.7% to 13.3% in nonexpansion states.[67] Concurrently, in expansion states there was a small but statistically significant shift toward the earlier diagnosis of colorectal, lung, breast, and pancreatic cancer and melanoma.[67] The ACA allows parents to maintain insurance coverage on their children up to age 26 years. This policy has resulted in a statistically significant 7% increase in insurance coverage, as well as a larger proportion of early-stage cancer diagnoses, among adults aged 19 to 25 years.[64,68] It has also improved the prevalence of vaccination against human papillomavirus and increased receipt of fertility-sparing treatment for cervical cancer among young women.[69]

Conclusions

In 1971, President Richard Nixon signed the National Cancer Act. This law created the National Cancer Program and began what many refer to as the War on Cancer. It funded the programs that collected much of the cancer epidemiologic and end results data used in this paper. It also catalyzed a tremendous research effort to learn about cancer and how to control it. A substantial proportion of the decline in cancer mortality over the past 3 decades would not have occurred without the knowledge gained from the National Cancer Program. However, the data presented herein clearly demonstrate one vital fact: We can do better. Many more cancer deaths could be prevented through wider adoption of known cancer preventive behaviors and interventions and broader access to high-quality cancer care. There are vast opportunities to reduce the cancer burden today, in the absence of new technologies or treatment, by expanding delivery of currently established evidence-based care to all Americans. ■

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